

# Soil Degradation from Intensive Forest Biomass Harvesting in the Western Gulf of Mexico

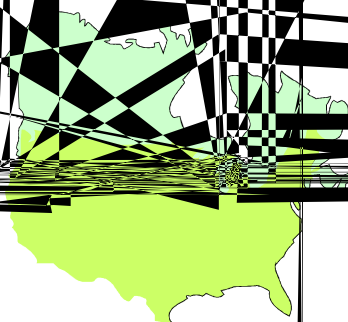
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Intensive forest harvesting of traditional wood products is an emerging issue for the West Gulf of Mexico. The potential to decrease soil quality and productivity and the sustainability of the key resource as timber rotation ages decrease and production increases to meet the goal of international Long-Term Soil Productivity study, with 100 field locations in North America, is to develop soil quality guidelines across large and small tracts of land with different harvesting treatments. Data can be used in conjunction with other information such as geology and topography to develop maps of productivity decline due to intensive harvesting. The study provides an opportunity to apply the results of long-term research on soil types with different management practices. The use of this data will be presented across the West Gulf of Mexico.

## INTRODUCTION

Tree growth and survival of trees left on site after harvesting of large amounts of timber for energy use of the forest and other trees, causing a reduction in productivity and timber biomass. Intensive harvesting of timber products and the demand for shorter rotation ages further impact on long-term productivity and sustainability will be key issues in the future. Therefore, site productivity and sustainability will be key issues in the future. A soil productivity system is necessary to provide information on the intensive biomass harvests and not on the productivity of the forest.

The international Long-Term Soil Productivity (LTSP) study is led by the USDA Forest Service to research and monitor the effects of forest management on long-term soil productivity. Program coordinators include National Forest System, US Forest Service Research, Canadian Forest Service, Columbia University, Ontario Ministry of Natural Resources, universities, and others. This study began in 1989 and now comprises over 100 LTSP and associated sites. The study is a global effort within Canada (Figure 1). Sites range over a diversity of climate, geology, and soil conditions that are likely to be under forest management.



Soil and site processes control site productivity, and soil organic matter and porosity, which regulates critical soil processes, are directly affected by management. LTSP's hypotheses target manipulation of these two key soil variables, with the objectives to: *i.* quantify the effects of soil disturbance on soil productivity, *ii.* validate standards and method for soil quality monitoring, *iii.* understand the fundamental relationships between soil properties, long-term productivity, and forest management practices, and *iv.* evaluate the potential for mitigating the adverse effects of disturbance. Organic matter removal and compaction treatments (3x3 factorial) have been applied to LTSP sites. Organic matter removal treatments include tree bole only (crowns, felled woody and herbaceous understory, and forest floor retained on site), whole-tree removal (tree boles and crowns removed with felled woody and herbaceous understory, and forest floor retained on site), and total removal (all aboveground biomass removed to bare mineral soil). Compaction treatments are no compaction, compacted to intermediate bulk density, and compacted to unusually high bulk density. Main soil physical variables, such as soil loss and soil bulk density, and soil chemical properties, such as soil nutrient status and cycling, are being monitored.

Forest harvesting is just one factor affecting soil productivity. Regional factors, such as climate, atmospheric deposition, or geography, and local factors, such as inherent soil nutrient deficiencies, erosion, or land use history, compound the impact of harvesting on soil productivity. LTSP has the ability to address these additional factors because of the extent of the variability of the research sites across the US and Canada. We propose the development of risk maps of potential productivity decline due to intensive harvesting. Data from LTSP could be used in conjunction with mappable soil information such as soil morphological, geological, and cultural influences on soil fertility to create such maps.

## **METHODS**

The proposed risk assessment maps for maintaining site productivity would be produced using the following information:

- i. Existing information from the LTSP studies and other established studies to develop guidelines for soil ratings for the sustainability of intensive biomass harvesting
- ii. Use the existing NASIS database from the USDA NRCS and laboratory soil chemistry studies to develop a soil fertility model based on soil taxonomy and morphology, parent material, and land use history
- iii. Merge the soil ratings with soil fertility maps to create maps of soil susceptibility to productivity losses following intensive biomass harvesting
- iv. Verify the model and susceptibility ratings on multiple operational trials

## **BENEFITS**

This proposed research will help to ensure maintenance of soil productivity on sites undergoing biomass harvesting, especially on timberland that is not fertilized. Many landowners cannot afford or choose to manage forested lands within inherent nutrient limitations, especially if timber production is not the primary management objective. Intensive biomass harvesting has the potential to increase in rural areas due to market demand, but long-term reduction in soil productivity could cause these markets to be non-sustainable. Few silvicultural tools help forest managers to assess the impacts of harvesting on productivity of poor quality land. This proposed research would develop the tools needed to ensure that soils with a high-risk of productivity decline would be identified so that management practices could be modified.

Soil properties, especially soil chemical properties, will differ not only by soil series but also by past land uses and management practices. An example of differences in extractable phosphorus (P) within a soil series is shown in Figure 2 (C. Bliss, unpublished data from the Santa Fe River Watershed in Florida). This supports the importance of the readily available, large database from LTSP which provides needed information for both regional and localized

ecosystems. An example of available data from LTSP on site productivity impacts due to intensive harvesting is shown from data collected from 10 LTSP sites in the western Gulf coastal plain. Whole-tree harvesting has been found to reduce productivity an average of 19% on unfertilized loblolly pine sites at age 10, with losses of up to 40% on sites with initially low pre-harvest extractable P (Scott and Dean 2006), showing the potential long-term impact of intensive harvesting. This data provides needed information on intensive management impacts across a soil gradient (fertility, hydrology, morphology) involving 6 soil series and will be used to show potential risk maps.

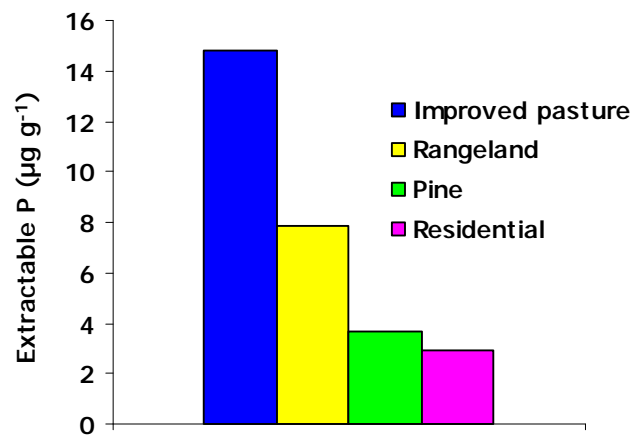


Figure 2: Differences in extractable P (0-10 cm depth) by land use in the Mascotte soil series.

The proposed risk maps would provide needed information to landowners and managers on the potential long-term impact on soil productivity due to biomass harvesting. LTSP not only provides regional data on key soil properties impacted by intensive harvesting, but also on more localized characteristics, such as inherent low soil fertility. This data could be used in conjunction with mappable soil information, such as geology, land form, and soil type, to develop risk maps of productivity decline due to intensive harvesting. The proposed study provides a unique opportunity to supply information of long-term impacts across soil types with differing forest management practices to landowners and managers, especially on sites that rely on inherent soil properties for sustainability.

## REFERENCES

Scott, D.A., and T.J. Dean. 2006. Energy trade-offs between intensive biomass utilization, site productivity loss, and ameliorative treatments in loblolly pine plantations. *Biomass Bioenergy*. 30:1001-1010.

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